Making and Testing Electromagnets

Electricity All Around Us
Activity
Grade Level: 5-8

Main Objectives

Learners will have an opportunity to work with electricity and wire to learn about some of the interesting and practical properties of magnetic fields. Learners will measure the magnetic field in two ways the first involving the use of a magnetic compass, the second using paper clips. This activity reinforced the idea that magnetic fields around a magnet have a shape, and that compasses and other sensitive instruments can be used to detect and measure the size and shape of the field.

Learning Outcomes

By the end of this activity, learners will:

- Describe at least two variables that can be changed to affect the strength of an electromagnet.
- Construct a simple electromagnet.
- Describe several applications of electromagnets in everyday life.
- Describe the effect of reversing the direction of current flow through the coil on the polarity of the electromagnet.

Length of Activity

1.5 hours

Materials List

Internet-enabled device
Making and Testing Electromagnets Learner Worksheet
Magnetic compass
Sandpaper
Scissors
10 cm iron nail
30 cm plastic ruler
3 metres of magnet wire
10 paper clips
1 AA or C sized battery with battery holder

Procedure

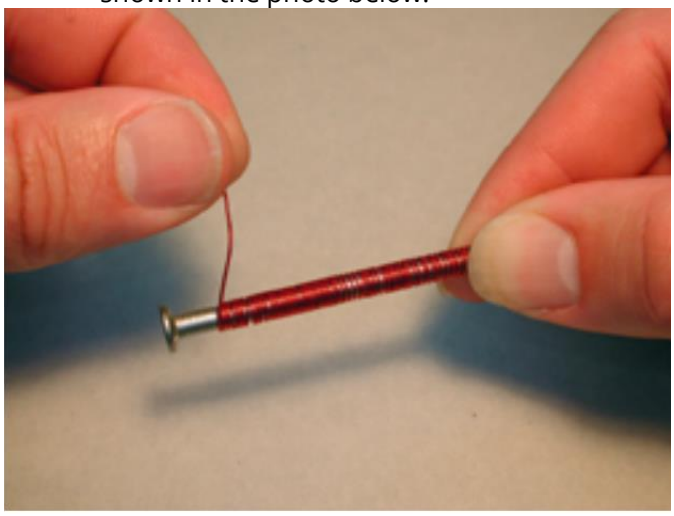
Step 1: Preparation

a. Educators will divide the class into groups of two or three and ensure that each learner has a copy of the learner activity worksheet.
b. Go over the instructions with the learners, as written, on the learner worksheet. Be sure to emphasize the following:
    I. Wrap the wire around the nail neatly and carefully, making the coils as tight as possible.
    II. Carefully sand the enamel off the ends of the wire to remove the insulation.
    III. Be careful not to connect the coil to the battery for more than a few seconds at a time. Do so just long enough to measure the strength of the magnetic field.
c. Distribute the materials to the learner groups.
d. Allow the learners about 15 minutes to make their first electromagnets. They may begin testing them as soon as they are built.

e. If possible, have the learners complete their data tables and questions in class.

Step 2: Make the first electromagnet

a. Use the sandpaper to remove about 2 cm of insulation from each end of the wire. You may need some help from your teacher to do this.
b. Carefully wrap 80 turns of wire around the nail. Make sure the wire is wrapped neatly, as shown in the photo below.



c. Test your electromagnet to see if it works. Connect the bared parts of the wires to the battery holder and check to see if the nail can attract paper clips or other metal objects. **Do not keep the magnet connected for more than 5 seconds!** Keeping it connected for longer will cause the battery to wear out. If your electromagnet works, go on to the next part of this activity. If it does not, ask your teacher for assistance.

Step 3: Experiment with your electromagnet

A. Detecting the electromagnet field (Magnet with 80 turns)

c. Place your electromagnet at one end of the ruler, as shown below. Place the compass at the other end.
d. Connect one wire from the electromagnet to the battery holder.
e. Touch the other wire to the other connector on the battery holder for a moment. Does the needle of the compass move? If not, move the compass a little closer to the electromagnet. Keep testing until you find the location where the compass needle begins to move slightly each time you touch the wire to the battery. Record the distance from the electromagnet to the compass in the table on your observation sheet.
d. Record the polarity of your electromagnet: Remember, opposites attract. So the polarity is the opposite of the direction indicated by the compass needle.

B. Measure the strength of the electromagnet (80 turns)

a. Place the paper clips in a small pile in front of you.
b. Connect the battery to your electromagnet and see how many paper clips you can lift in a chain. Record the number of paper clips lifted on your observation sheet.

C. Detecting the field of an electromagnet with 160 turns

a. Add another 80 turns of wire to the nail. Wrap the wire around the nail as neatly as you can.
b. Place your electromagnet at one end of the ruler, as before.
c. Move the compass until you find the location where the compass needle begins to move. Record in the table on your observation sheet the distance from the electromagnet to the compass.
d. Record the polarity of your electromagnet.

D. Measure the strength of an electromagnet with 160 turns

a. Connect your electromagnet and use it to lift as many paper clips as it can in a chain.
b. Disconnect the electromagnet and count the number of paper clips lifted. Record this number on your observation sheet.

E. Test the effect of reversing the connection to the battery

a. By disconnecting the battery and switching the wires, you can cause electricity to flow through the wire in the opposite direction. What effect does this have on the field around the electromagnet? Try it and record your observations. Clue: The compass tells the story!

Tips and Extensions

- Stripping the enamel from magnet wire is much easier to do if you heat the ends of the wire with a match or lighter, then sand lightly to remove the reside.
- Bring an old speaker or electric motor to class to show the learners practical applications of electromagnets. If these objects can be disassembled, the learners will be able to see how electromagnets are used in appliances and other types of devices.
- If you have equipment and extra time, have the learners vary the number of batteries in the experiment: Add a second battery **in series** in increase the voltage. Learners could then evaluate the effect changing the voltage has on magnet strength.

Comprehension

- What are some ways to increase the strength of electromagnets? Prove to see if learners understand that the strength of the current and the number of coils are the primary factors affecting the strength of the field.
- Can you find examples of devices in the school room that use electromagnets?